Biomass to BCO to synthesis gas to fuels and chemicals:
BCO as a vector facilitating integration of biomass into existing petrochemical industry

Desmond Radlein*, Jan Piskorz, P. Majerski
Resource Transforms International Ltd.
110 Baffin Place, Unit 5, Waterloo, ON, Canada N2V 1Z7
Fax: 519-884-7681; dradlein@rtiltd.com

Gasification of biomass has been a well-known art for many years though large-scale commercialization appears to be slow. It is possible that this has been the case not only for technical reasons but perhaps because it requires simultaneous integration of the gasifier with both a biomass supply system and the gas utilization system. Furthermore, the lower cost air blown gasifiers produce a lower quality gas which limit the options for ways in which the gas may be utilized.

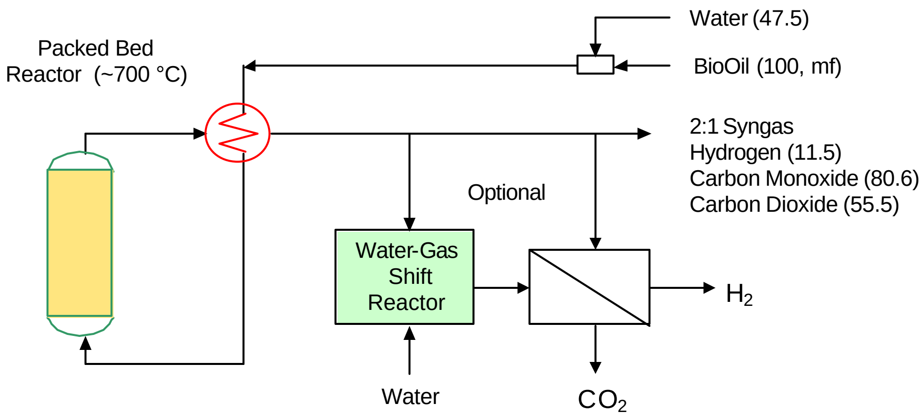
Biooil or Bio Crude Oil (BCO) is the liquid product of the pyrolysis of biomass – particularly from these processes that have been optimized to maximize liquid yield. Several different BCO producing pyrolysis technologies are currently under development at various companies including Dynamotive, Ensyn, BTG and Pyrovac. (For reviews of the current art see [1]). While pyrolysis is usually of lower thermal efficiency than gasification, BCO production does offer a route to biomass utilization that obviates some of the logistic roadblocks, referred to above, that make direct gasification problematic. On account of its far greater energy density than the original biomass, BCO could be produced at sites remote from its ultimate use point, stored and shipped, all at relatively low cost.

The direct combustion of BCO in gas turbines, slow speed diesels and boilers has been demonstrated, [1]. Furthermore the direct use of BCO for the production of a limited range of chemical products like resins and fertilizers has been reported, though its physicochemical properties are such that it is likely that the options for direct utilization will ultimately remain rather limited.

The most obvious route to integration of BCO into current commercial power and petrochemicals technologies is through steam reforming to synthesis gas or hydrogen. This would enable integration of biomass into existing hydrogen or synthesis gas based systems like methanol production, Fischer-Tropsch gas-to-liquids (GTL) technologies and fuel cells. Because of its high oxygen content (~40 wt%), BCO should in principle be more reactive and hence more easily reformed than conventional hydrocarbons like natural gas. Nevertheless, this same higher reactivity implies a certain degree of thermal instability that creates technical challenges that have yet to be solved in a satisfactory way, [2]. A tentative system might appear as illustrated in Fig. 1.

As an example of the potential for this approach, Table 1 examines the case of Fischer-Tropsch technology. It suggests that such a process has a chance to be economically competitive. Similar conclusions apply to methanol synthesis and to hydrogen for ammonia synthesis and fuel cell power systems.

E.g. 3.83 H_2O + $C_6H_9O_4$? 4.17 CO + 8.33 H_2 + 1.83 CO_2
??????? H = + 4.0 MJ/kg mf BioOil



H_2O + CO ? CO_2 + H_2

Fig. 1: Catalytic Steam Reforming of BCO

Table 1: Cost Estimates of Fischer-Tropsch synthesis via BCO

Overall Reaction from BCO is :

$C_6H_9O_4$? ?4 (-$CH_{2.25}$-) + 2 CO_2; ?H = -1.04 MJ/kg mf BioOil

Assume:	?? 100 tpd scale pyrolysis plants ?? Zero feedstock cost for Biomass
Then:	?? BioOil production cost is US$62/tonne (*Pyne Newsletter, March, 1999)*
Asume:	?? 3.5 – 4 tonne BioOil required per tonne F-T liquids ?? BioOil reforming cost is half that for Natural Gas For a 2000 bbl (400 tonne) /day plant, reforming + synthesis cost is ~ US$66/tonne F-T liquid product *(Based on Syntroleum estimates)*
Then:	?? Production cost of F-T liquids from BioOil is US$280 – 315 /tonne ?? This is in a range that would be commercially interesting even today ?? Compare BioDiesel where production costs are estimated at US$530-770/tonne *(DOE estimates)*

Progress in the development of a practical BCO reformer will be reported. So far we have achieved >98% carbon conversion to gas. The remaining technical issues will be discussed.

References

1. PyNe Newsletter, Issue 10, Dec. 2000.
2. D. Wang, S. Czernik, D. Montané, M. Mann and E. Chornet, Ind. Eng. Chem. Res., *36*, 1507, 1997.